AECD-2672

UNITED STATES ATOMIC ENERGY COMMISSION

EFFECT OF DIFFERENT GASES ON PHILIPS GAUGES

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Date of Manuscript: June 17, 1944
Date Declassified: August 23, 1949

Technical Information Branch, Oak Ridge Extension
AEC, Oak Ridge, Tenn., 9-26-49--850-A14047

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The object was to determine the relative effects of air, nitrogen, oxygen, helium and water vapor on Philips gauges.

To determine this, a tank containing Philips gauges was filled with each of the gases in question. The gases were admitted through a variable leak. With this control of the tank pressure, the tank and lines were flushed with each new gas. Then, starting from the best vacuum obtainable, a series of pressure points were taken by opening the leak.

Two Philips gauges of different geometry were used. The gauge designated as #1, has a 1" spacing between the copper cathode plates and a copper plate with a 1" diameter hole for an anode. There were no side plates. Number 2 gauge had 1/2" spacing between plates and a wire-ring anode. It formed a box around the anode - except for one end which was open.

The results are shown on the graphs which accompany this report. The curves given are the Philips and D.P.I. gauge readings vs. the oil McLeod standard. This was selected as the standard, after it was checked with a mercury McLeod, the former being the most sensitive, absolute gauge available. The check against the mercury McLeod is shown on the last graph. The Philips gauge vs. Distillation Products Ion gauge curves are not shown since they are essentially straight lines. The pressure in microamperes of the D.P.I. varied in direct proportion with the emission in every case. The P.I.G. and D.P.I. gauges vs. McLeod varied considerably with the time a new gas had been in the tank and with the time that the Philips gauge had been continuously operating. The results given were taken after conditions had become sufficiently stable

that the curves could be repeated on check points. Using air as standard, the relative sensitivity of the P.I.G. and D.P.I. gauges to the different gases were:

PRESSURE	1×10^{-4} m.m. Hg.			2×10^{-4} m.m. Hg.		
Gauge	PIG #1	PIG #2	DPI.	PIG #1	PIG #2	DPI.
Helium	0.23	0.21	0.19	0.27	0.21	0.20
Hydrogen	0.54	0.40	0.535	0.50	0.39	0.58
Oxygen	0.97	1.0	0.96	0.96	0.97	0.92
Nitrogen	1.0	1.0	1.03	1.0	1.0	1.07
Air	1.0	1.0	1.0	1.0	1.0	1.0
Water Vapor	1.45	1.58	1.96	1.47	1.47	2.25

Some of the details of the apparatus may have a considerable bearing on the results. The Philips gauges were both supplied from the same half-wave rectifier. The voltage was regulated manually at 2.0 K.V. across each P.I.G. and a 1 megohm series resistor with each gauge. The D.P.I. gauge, oil and mercury McLeod gauges were attached to the tank through liquid nitrogen traps.

Bottles of compressed gas supplied the nitrogen, helium, hydrogen and oxygen. Air was atmospheric. Water vapor was secured from a sealed flask partially filled with water and pumped out through the tank. The liquid nitrogen traps were blown dry for water vapor and no readings were taken until the surface of the water was still. This indicated that gas was no longer appreciably escaping from the walls of the flask. With the leak constant at the highest point on the curve, liquid nitrogen reduced the D.P.I. and McLeod readings by 2/3. This was a rough check that the atmosphere in the tank was largely water vapor. P.I.G. readings not directly affected by the traps were reduced 25%.

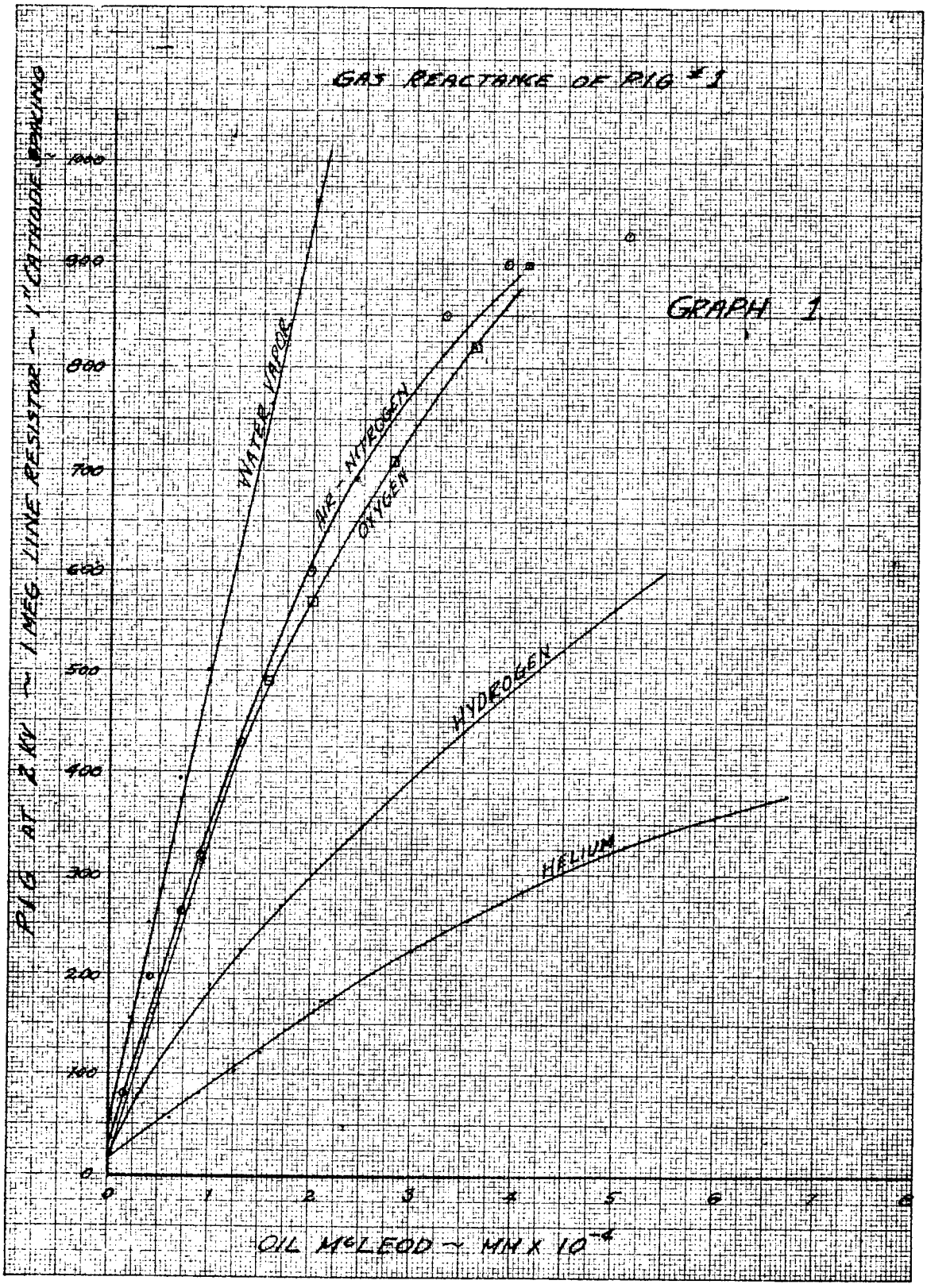
The main difficulties encountered were in getting consistent results on the same gas. It was possible to get a smooth plot at any one time, but the data tended not to check at a later time. With helium, which was introduced after oxygen, the tank was soaked in helium overnight. The results taken in the morning were 100% higher than those in the afternoon. Those in the afternoon repeated themselves the next day. This change was observed with other gases but to a much lesser extent (about 20% change.) Helium also repeated itself in showing a 7% variation between continuous operation of the P.I.G. and intermittent operation. A drying trap in the air leak might give slightly improved results on future experiment.

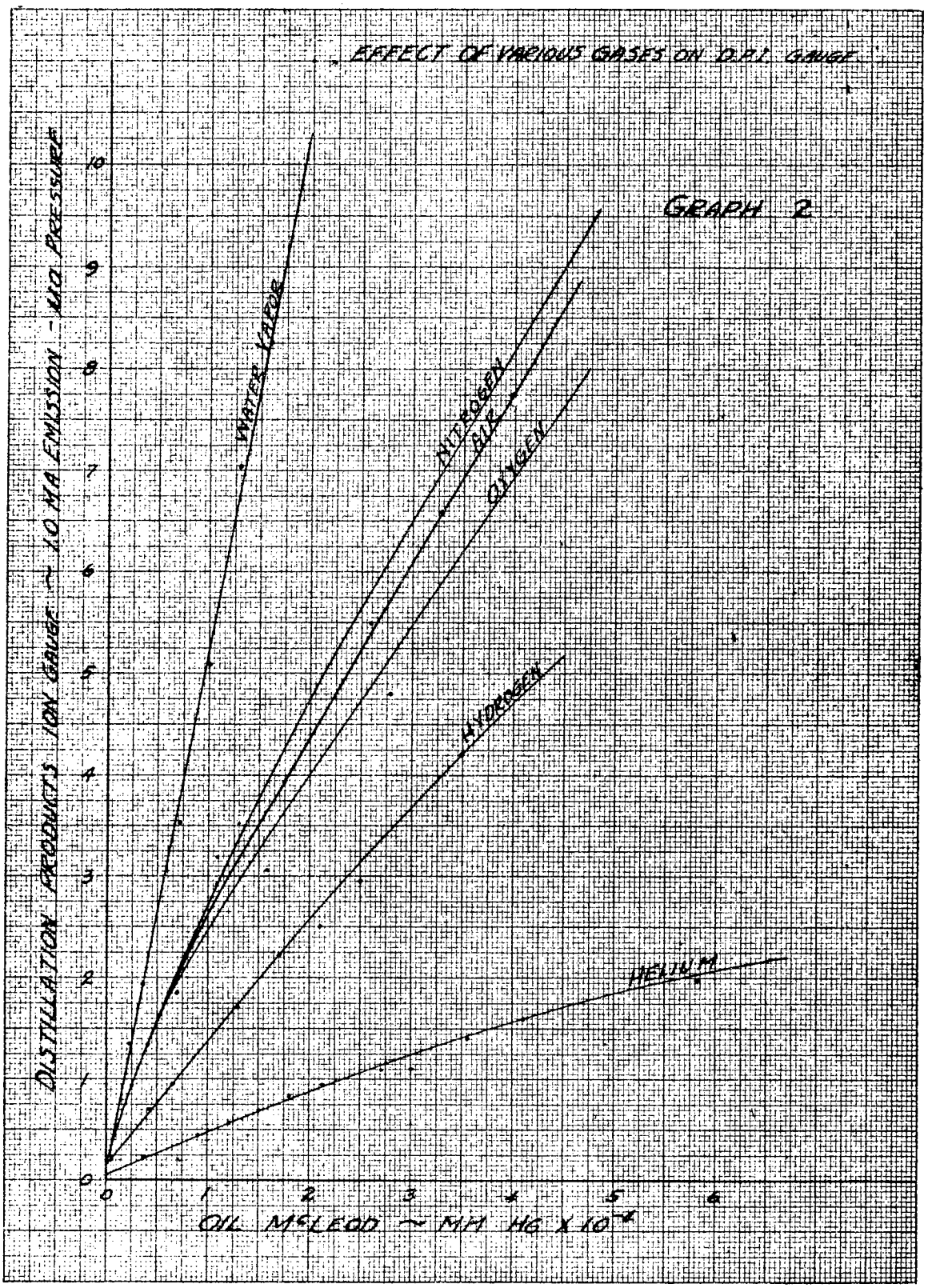
We expect at a later date to run similar tests on carbon monoxide.

Submitted by:

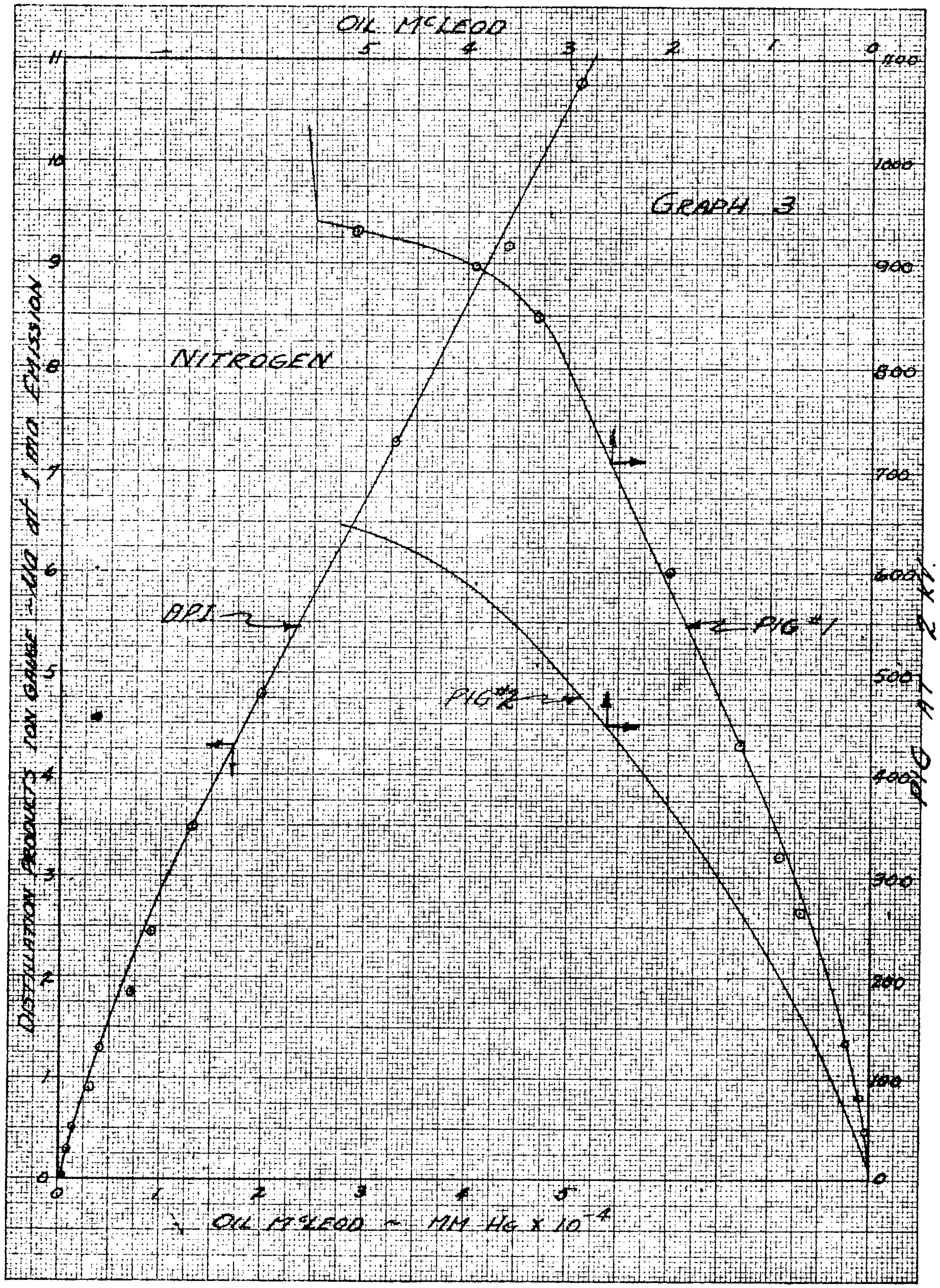
Lawrence R. Foote
June 17, 1944

Vac. Special #25

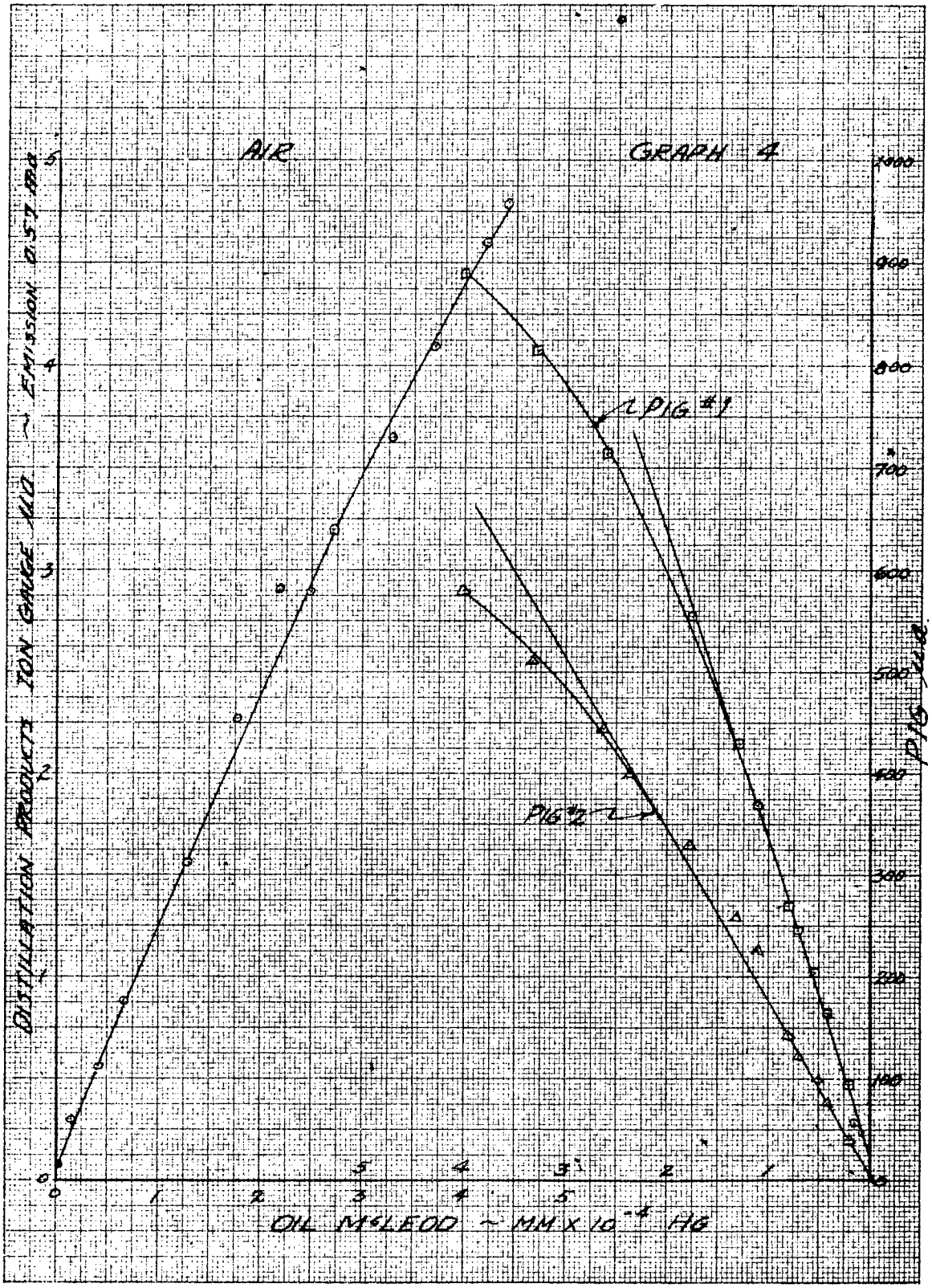



EFFECT OF VARIOUS GASES ON D.P.I. GAUGE
GRAPH 2
DISTILLATION PRODUCTS ION GAUGE ~ 10 MA EMISSION - MID PRESSURE
WATER VAPOR
NITROGEN
AIR
OXYGEN
HYDROGEN
HELIUM
0
1
2
3
4
5
6
7
8
9
10
OIL McLEOD ~ MM HG X 10⁻⁴

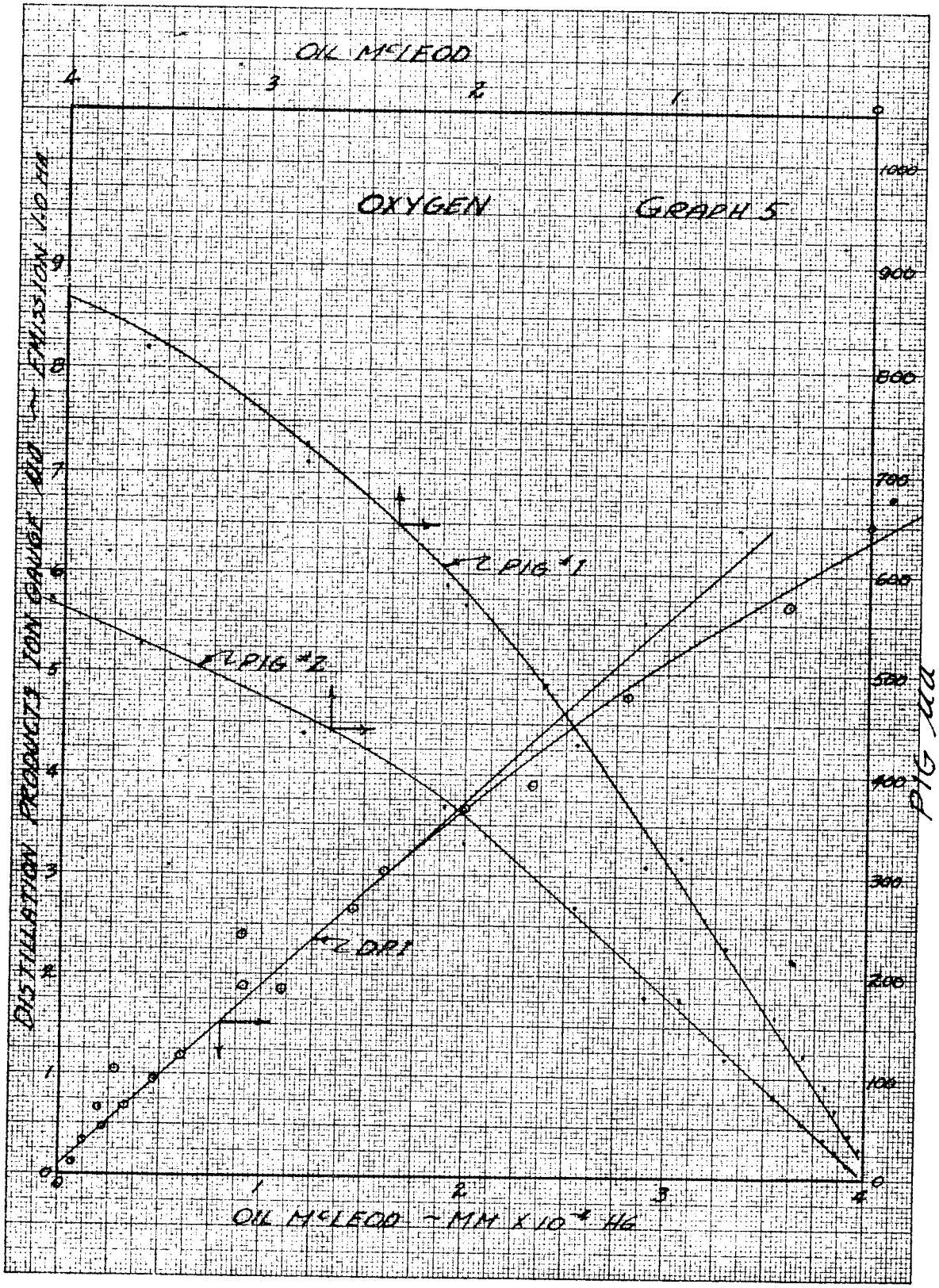
VAC. SPEC #25


OIL McLEOD
GRAPH 3
NITROGEN
DPI
PIG #1
PIG #2
DISTILLATION PRODUCTS ION GAUGE ~ μA AT 1 MA EMISSION
PIG AT 2 KV.
OIL McLEOD ~ MM Hg x 10^-4

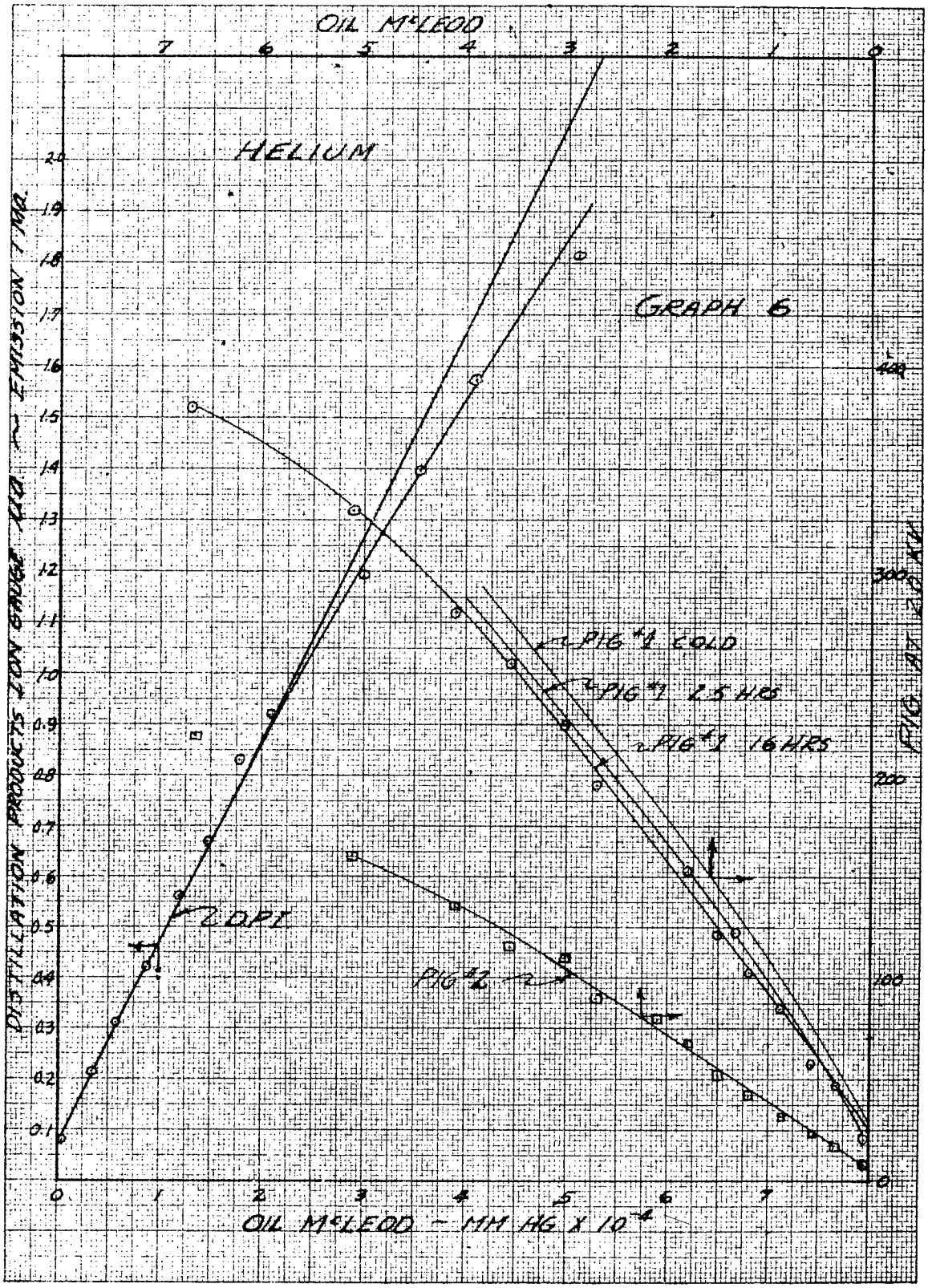
VAC. SPEC #25 7


AIR
GRAPH 4
DISTILLATION PRODUCTS ION GAUGE MM ~ EMISSION 0.57 MA
OIL McLEOD ~ MM x 10⁻⁴ HG
PIG #1
PIG #2
PIG #3
0
1
2
3
4
5
100
200
300
400
500
600
700
800
900
1000

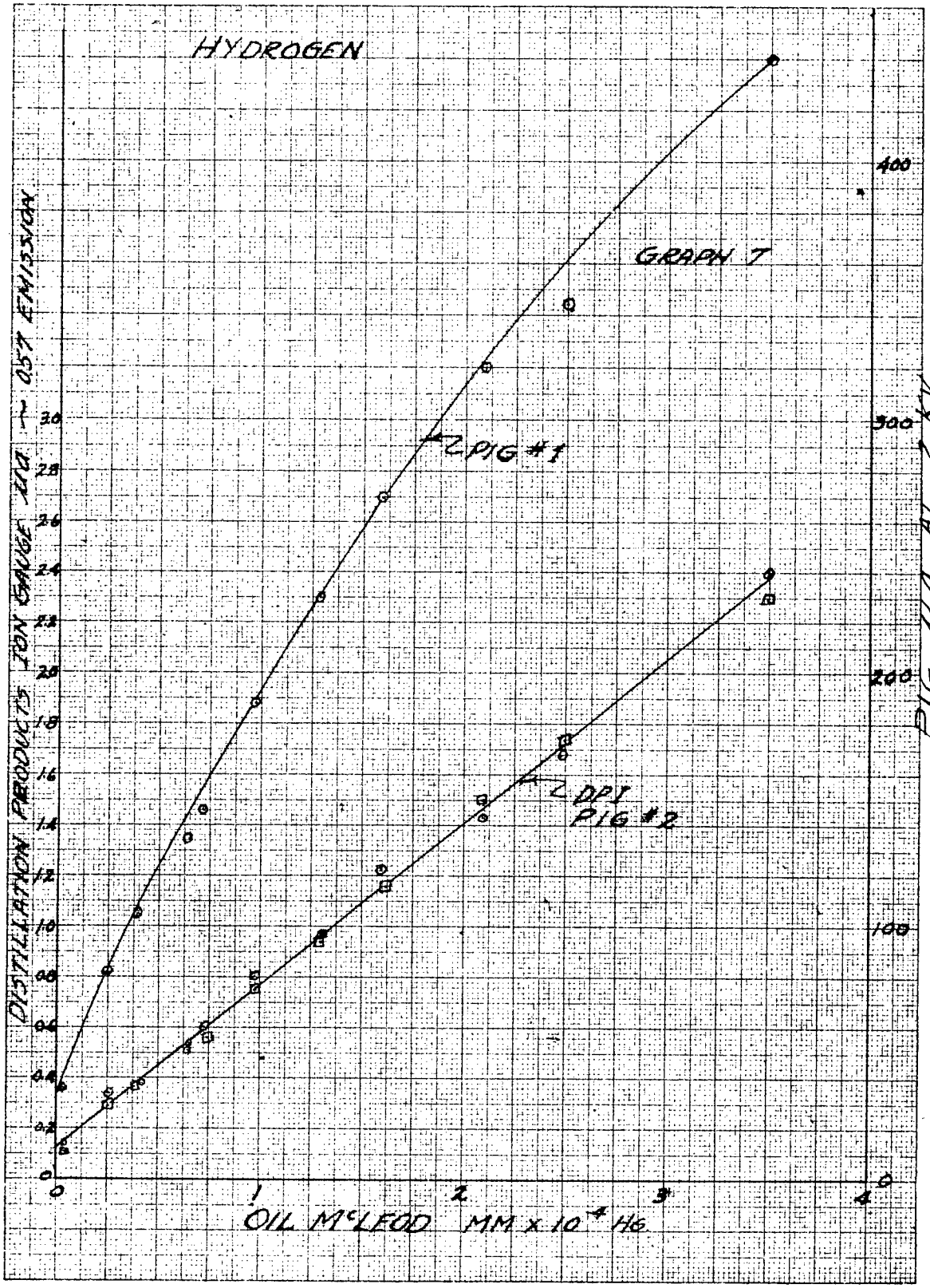
VAC SPEC #25

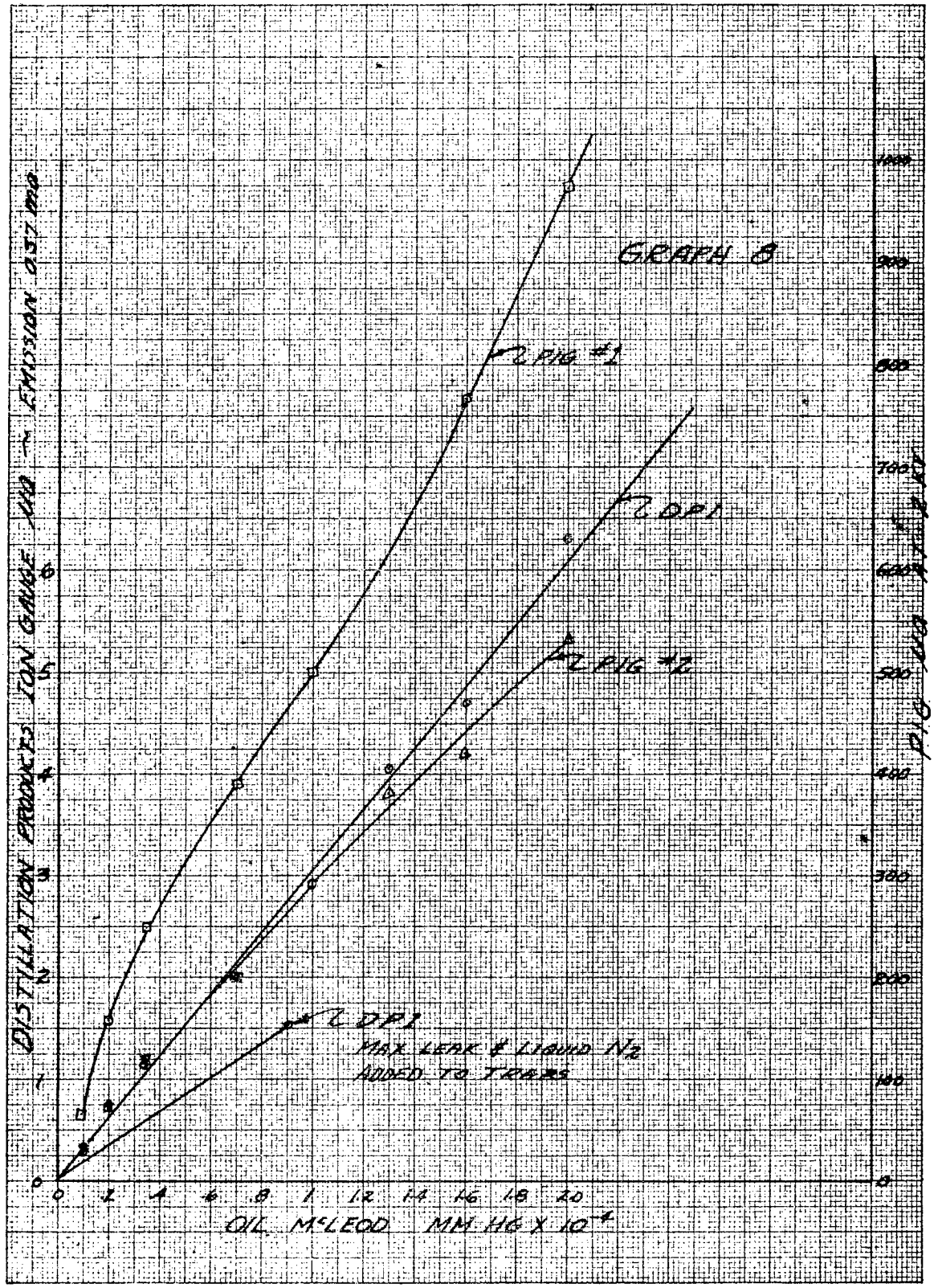


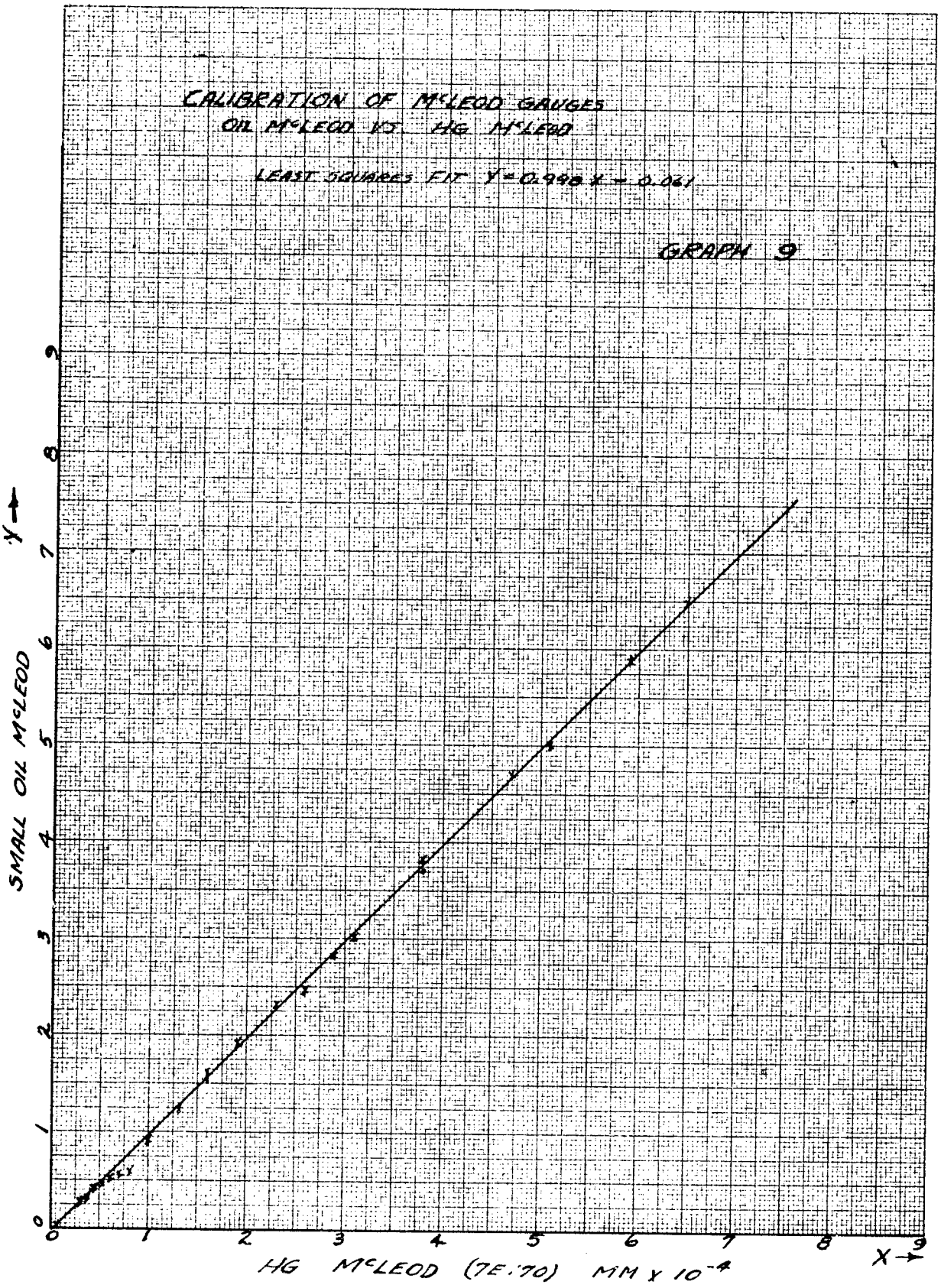
PIG #1

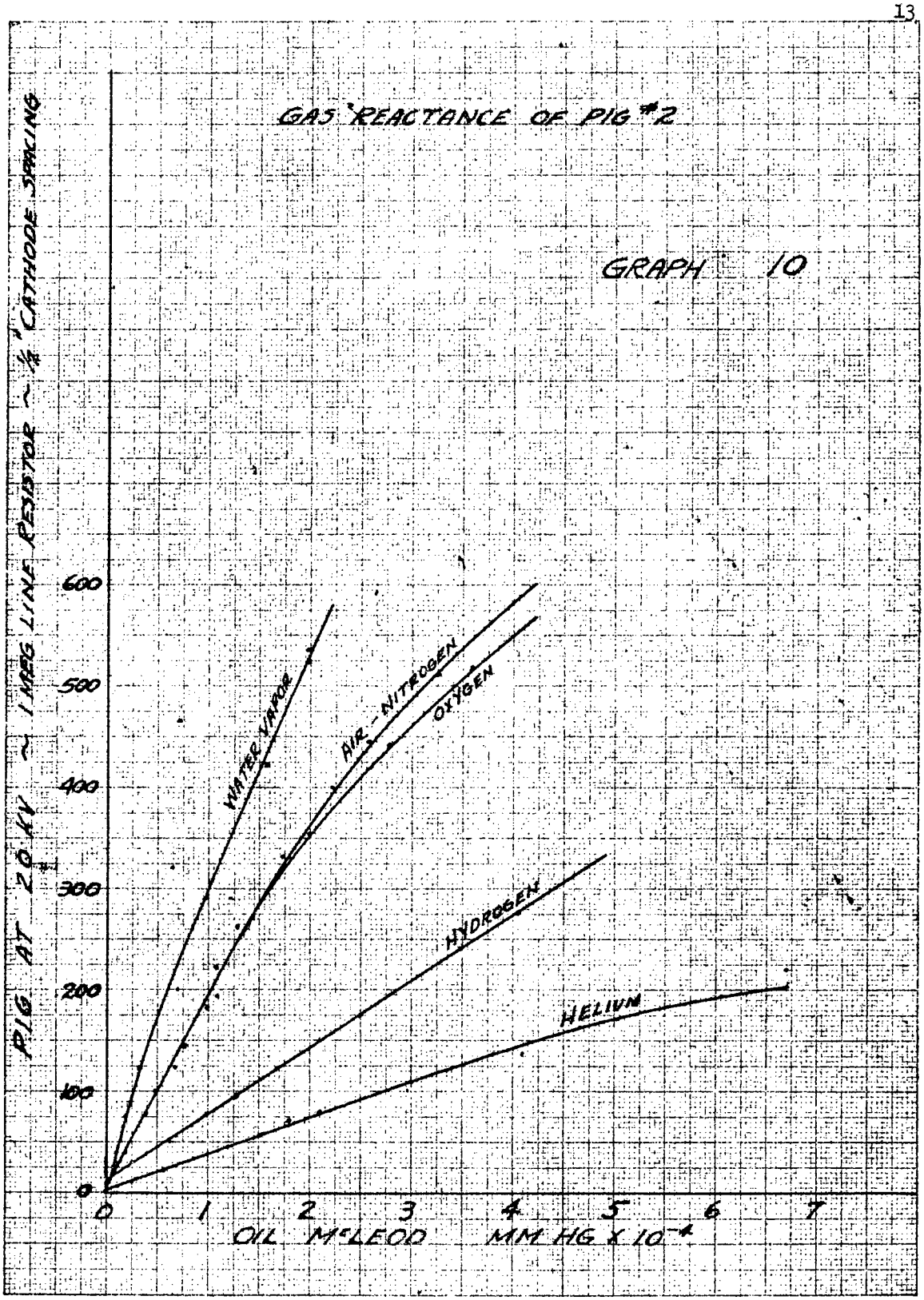

OIL McLEOD
HELIUM
GRAPH 6
DISTILLATION PRODUCTS ION GAUGE MIN ~ EMISSION 1 MA.
OIL McLEOD - MM HG X 10⁻⁴
FIG #1 COLD
FIG #1 2.5 HRS
FIG #1 16 HRS
2 DPT
FIG #1 - 2

VAC SPECIAL #25




GRAPH B
2 PIG #1
2 DPI
2 PIG #2
2 DPI
MAX LEAK # LIQUID N2
ADDED TO TRAPS
DISTILLATION PRODUCTS ION GAUGE MM HG ~ EMISSION 237 MA
OIL McLEOD MM HG X 10⁻⁴
0 2 4 6 8 10 12 14 16 18 20
0 2 4 6 8 10
0 100 200 300 400 500 600 700 800 900 1000


CALIBRATION OF McLEOD GAUGES
OIL McLEOD VS. HG McLEOD
LEAST SQUARES FIT Y = 0.998 X − 0.061
GRAPH 9
SMALL OIL McLEOD Y →
HG McLEOD (7E.70) MM X 10⁻⁴ X →
0
1
2
3
4
5
6
7
8
9



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